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WGL-MLR 89-41

Feasibility of a Super High Energy Density Battery of the Li/BrF_3 Electrochemical System

Michael F. Pyszczek
Steven J. Ebel
Christine A. Frysz

Wilson Greatbatch Ltd.
10,000 Wehrle Drive
Clarence, NY 14031

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16. Abstract (Limit: 200 words)

The feasibility of developing a lithium/bromine trifluoride battery is being studied. Critical to this product development is materials selection. Consequently, efforts have been directed toward identifying candidate porous electrode separators, glasses for insulated electrical feed-throughs and metals for lid, case and current collector fabrication. Samples were evaluated via electrochemical testing techniques and one month storage in Teflon vials. Vial test results for metal samples did not vary significantly from those reported in technical report 0001AA. Of the separator samples tested, Raychem proves to be most promising. Further study is required regarding glass selection. Electrochemical testing is still in progress.

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lithium battery

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FIGURES AND TABLES

INTRODUCTION

Since technical report 0001AA, materials compatibility tests with bromine trifluoride have continued. Efforts have focused on identifying candidate porous electrode separators, glasses for insulated electrical feed-throughs and metals for lid, case, and current collector fabrication. Test results are summarized below.

POTENTIODYNAMIC POLARIZATION

Potentiodynamic polarization experiments provide a qualitative means of studying the behavior of a metal under precise and reproducible conditions in any electrolyte medium. The test electrode potential can be established at any desired value relative to a reference electrode providing a standard potential by which material behavior comparisons can be made.

Material response in lithium bromine trifluoride electrolyte was assessed utilizing this electrochemical technique. The potentiodynamic polarization procedure as outlined in the ASTM method G5-87 entitled "Standard Reference Method for Making Potentiostatic and Potentiodynamic Polarization Measurements" was followed with two exceptions: (1) the test cell and (2) the scan rate.

The cell specified in ASTM G5-87 has a working capacity of one liter. After each run the solution is discarded. Because of the reactive nature of lithium bromine trifluoride, an alternate teflon cell with a 5 ml capacity was designed, see Figures 1 through 3. The reference and auxiliary electrodes are held in place by a Gortex® gasket and an electrode holder, see Figure 4. The test cell design allowed for blanketing the internal cell environment with argon at positive pressure to eliminate obscuring the test results by reactivity with air. The working electrode, a .625 inch diameter disk, is inserted against a Kalrez® o-ring. A hollow teflon screw with a nickel wire provides electrical connection to the system when assembled. The chamber is sealed with a teflon stopper.

To evaluate the performance of the cell, a potentiodynamic polarization scan of 430 SS in 1N H2SO4 solution was completed in accordance with ASTM G5-87. The scan, however, was performed at .2 mV/s rather than the specified .167 mV/s. A typical scan obtained with this cell, which is superimposed on the ASTM Standard Polarization Plot,

is shown in Figure 5. Since the results obtained were within the limits of the ASTM plot, the scan rate remained at .2 mV/s.

Samples were cathodically then anodically polarized from -1000 mV to 2000 mV using platinum wire as reference and auxiliary electrodes. Current densities were measured over this potential range. Polarization characteristics were obtained by plotting the current response as a function of the applied potential via a log current function versus a potential semi-log chart.

Completed to date are:	Superferrit
	nickel 200
	aluminum 1145-0
	29-4-2
	Shomac
	316 L SS
	Monel 400

Figures 6 through 12 display the plots obtained. Comparison evaluations will be performed upon completion of the remaining experiments.

ONE MONTH STORAGE METAL SAMPLES

Ten metal samples were prepared and tested as outlined in technical report 0001AA. Table 1 lists the results for the metals tested. After one month room temperature bromine trifluoride exposure, pre and post weight changes were insignificant. Observations made by SEM were comparable to those reported in report 0001AA.

SEPARATOR EVALUATION

The following separators were evaluated: (1) Whatman BSF45, (2) Kaowool 90105-01, (3) Hollingsworth and Voss (H&V) BG03013 LN 96835, and (4) Rayperm 200/60. Whatman and H&V are glass fiber separators. Whatman is binderless and H&V contains an acrylic binder. Kaowool is primarily a ceramic fiber separator. A small percentage of glass fiber is also present. A latex binder is used for fabrication. Compatibility was studied by adding 0.10 ml of bromine trifluoride to a .250" X 1.000" sample. The Whatman separator disintegrated within 2 seconds. A pyrophoric reaction was observed for the Kaowool. The Hollingsworth and Voss separator reacted with incandescence. No visible

reaction was observed for the Rayperm separator, consequently, this material was placed in a teflon PFA vial into which bromine trifluoride was added. Storage was as previously described for the metal samples. The Rayperm separator was visually examined through the vial after one month of storage. The electrolyte remained clear and the sample appeared pliable and in good condition. Rayperm will be reexamined after three months of room temperature storage.

GLASS EVALUATION

Also critical to battery performance is retention of glass to metal seal integrity. The following glasses/ceramics were weighed and stored in bromine trifluoride for one month as noted above:

Fusite 435
K brown
T clear
TA23
Cabal 12 - etched and as received
TM9 B
9013 Mansol
9013 Corning
Fusite A485
Fusite MSG 12
Fusite R1
alumina

Of the materials tested, bubble evolution was immediately observed for T clear, TM9 B, Mansol and Corning 9013, Fusite R1, 435 and A485, K brown, and T black. Upon removal from the test vial after one month, all these samples were observed to be visibly etched with K brown and TM9 B disintegrating upon handling. Table 2 summarizes the results obtained. SEM examination remains to be completed.

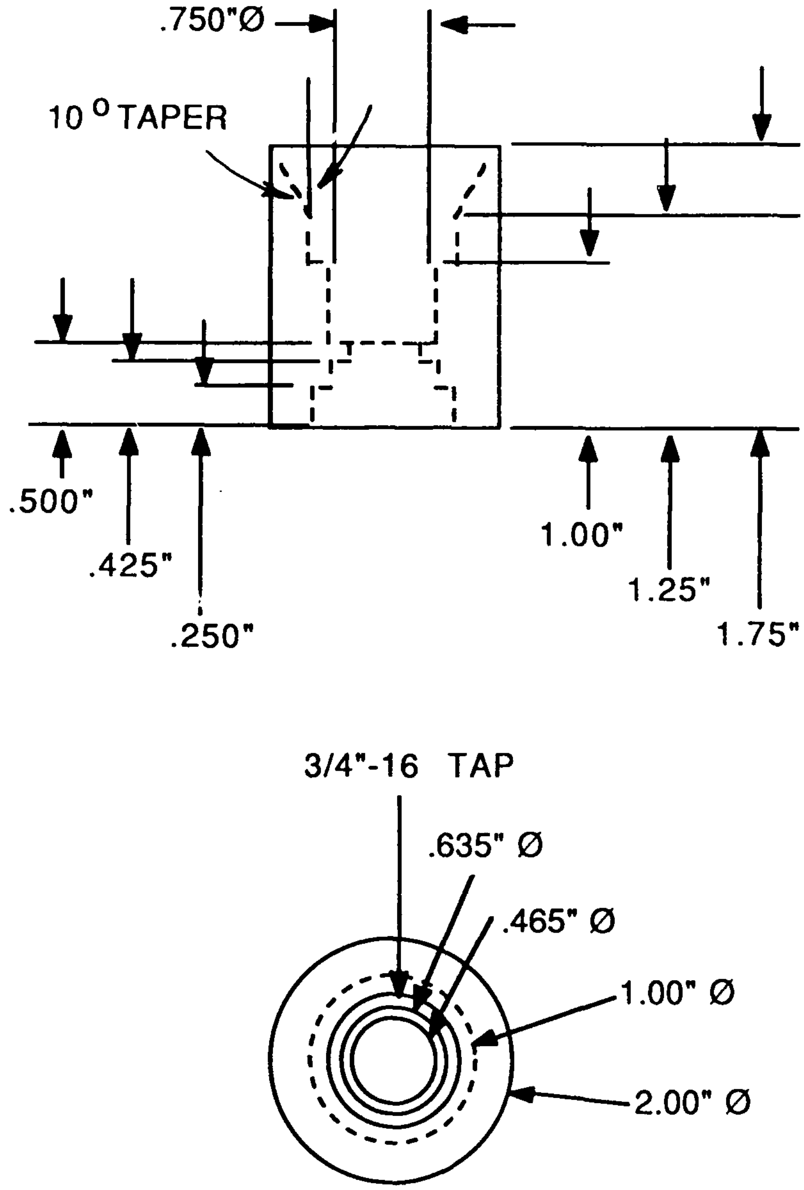
TABLE 1 - GLASS EVALUATION RESULTS

SAMPLE	PRETEST WT. (g)	POST TEST WT. (g)	OBSERVATIONS
Fusite 435	0.526	0.529	etched
K Brown	0.104	0.07	partial disintegration
Fusite A 485	0.359	0.356	etched
as rec'd Cabal 12	0.063	0.064	slight discoloration
etched Cabal 12	0.064	0.065	slight discoloration
TM9 B	0.04		disintegrated
9013 Mansol	0.245	0.23	etched/discolored
9013 Corning	0.024	0.031	etched/discolored
Alumina	0.233	0.246	no discoloration
Fusite R1	0.243	0.253	etched/discolored
MSG 12	0.141	0.18	etched/discolored
TA-23	0.007	0.007	no discoloration
T clear	0.514	0.512	etched/discolored

TABLE 2 - METAL EVALUATION RESULTS

SAMPLE	PRETEST WT. (g)	POST TEST WT. (g)
Mild steel	0.304	0.302
29-4-C	0.104	0.103
Shomac	0.055	0.054
Nickel 200	0.408	0.407
Hastelloy G 30	0.657	0.656
Superferrit	0.133	0.133
316 L SS	0.031	0.03
304 L SS	0.013	0.012
Aluminum	0.024	0.023
Monel 400	0.192	0.192

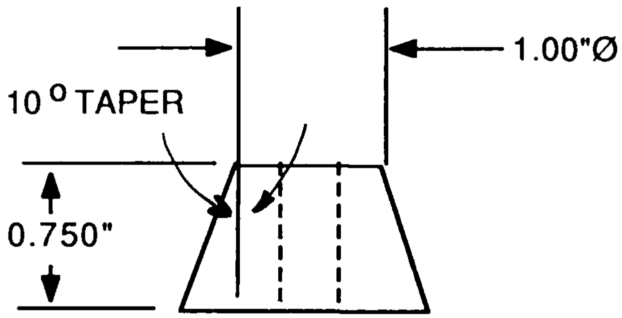
Figure 1

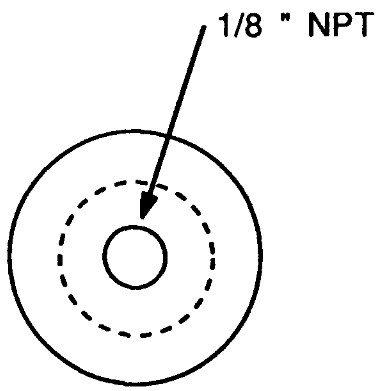


NOT TO SCALE
MATERIAL: TEFLON

WILSON GREATBATCH LTD. TECHNOLOGY DIVISION		
TEST CELL		
Drawn by C. Frysz	Date 15 Dec 89	Dwg. No. **6T1225-1**

Figure 2

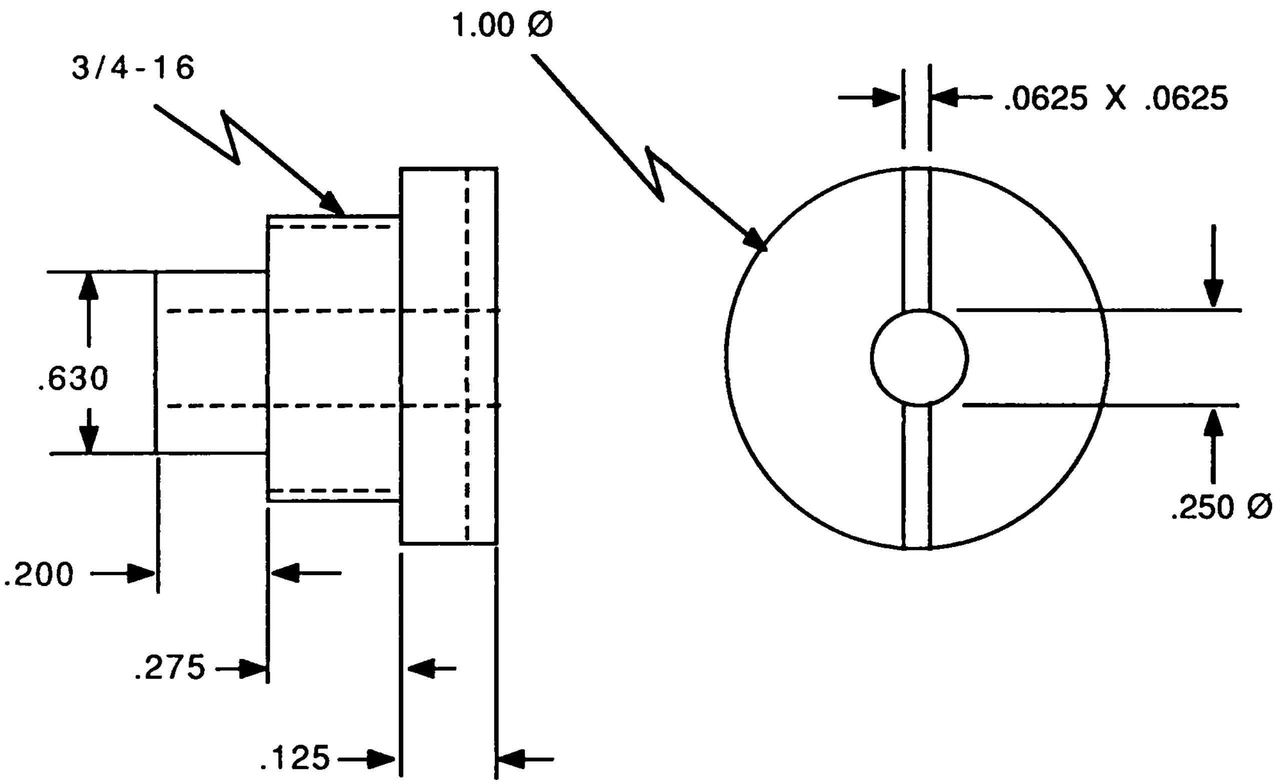




NOT TO SCALE
MATERIAL: TEFLON

WILSON GREATBATCH LTD. TECHNOLOGY DIVISION		
TEST CELL CAP		
Drawn by C. Frysz	Date 15 Dec 89	Dwg. No. **6T1225-2**

Figure 3

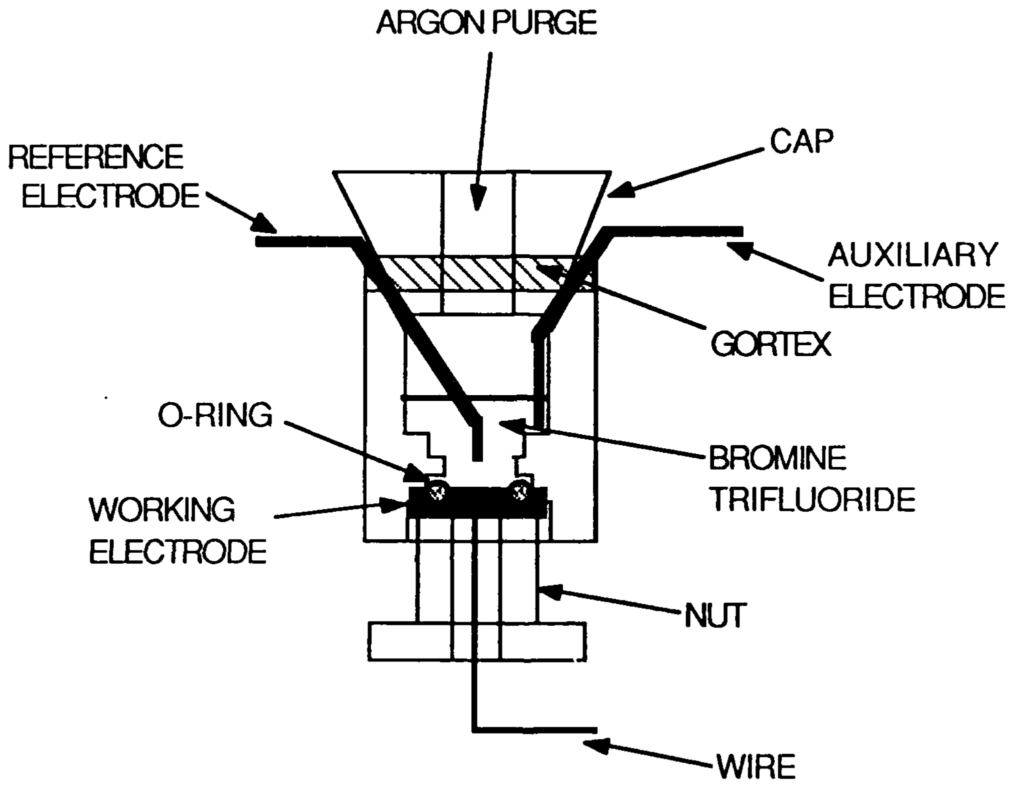


MATERIAL:
-TEFLON

NOT TO SCALE
DO NOT SCALE

WILSON GREATBATCH LTD. TECHNOLOGY DIVISION		
NUT		
Drawn by C. Frysz	Date 2 June 89	Dwg. No. **6T1170-3**

Figure 4



Test Cell Assembly

Figure 5

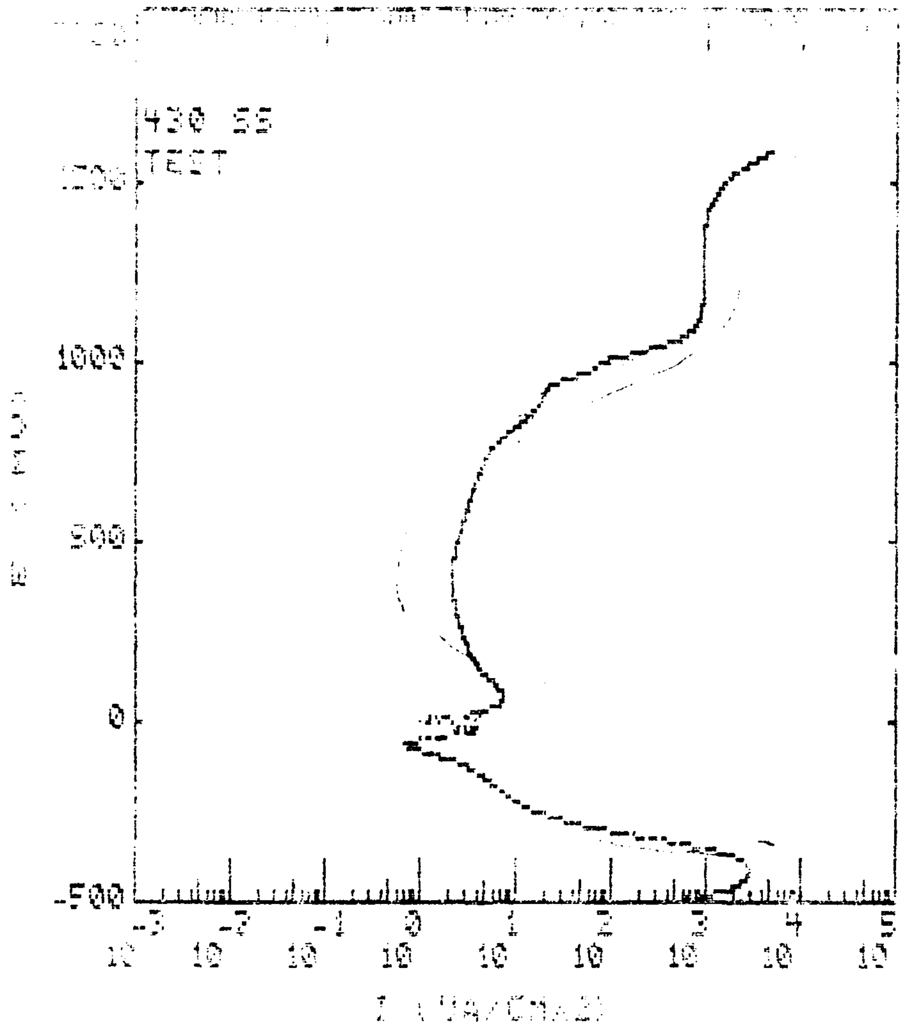


Figure 6

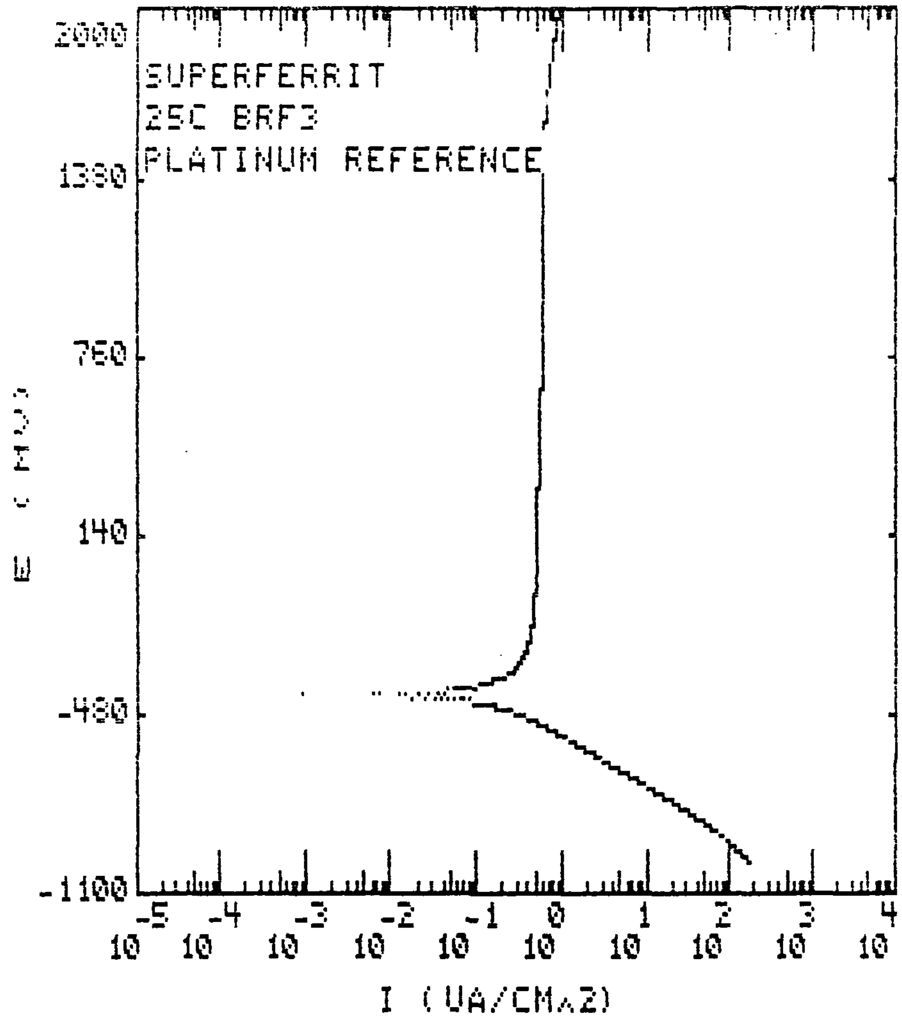
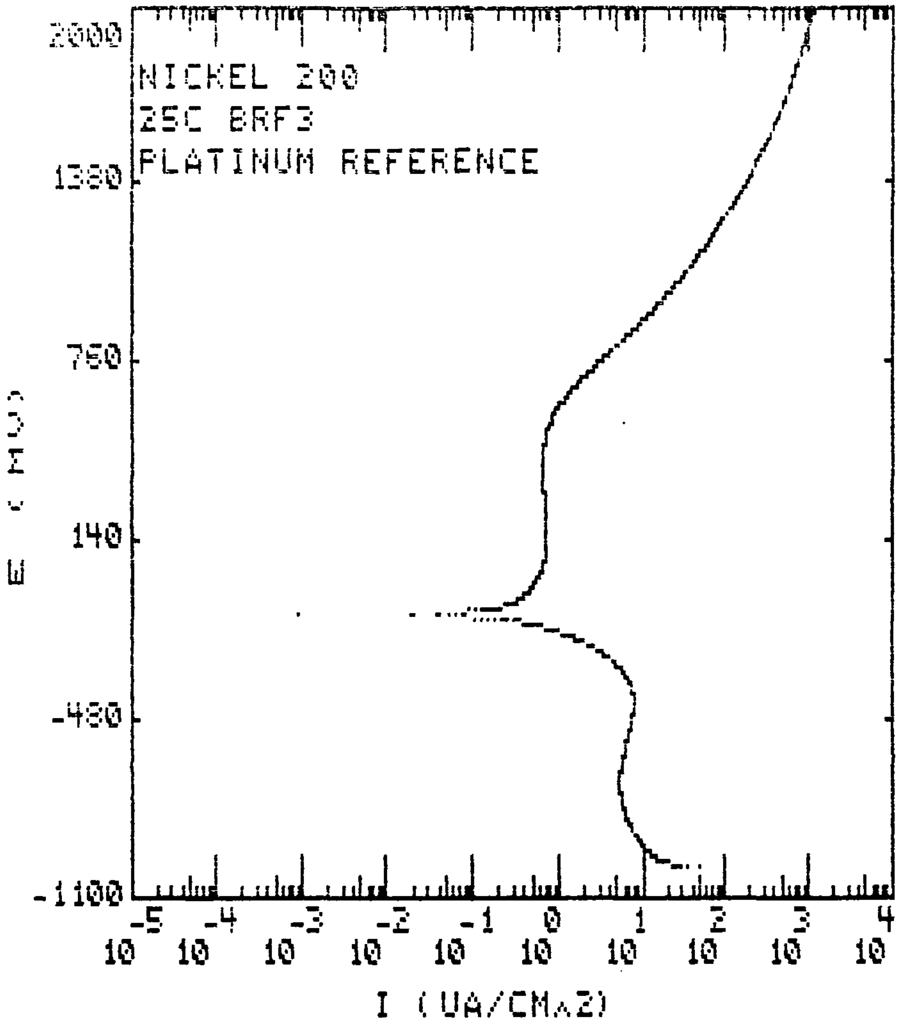
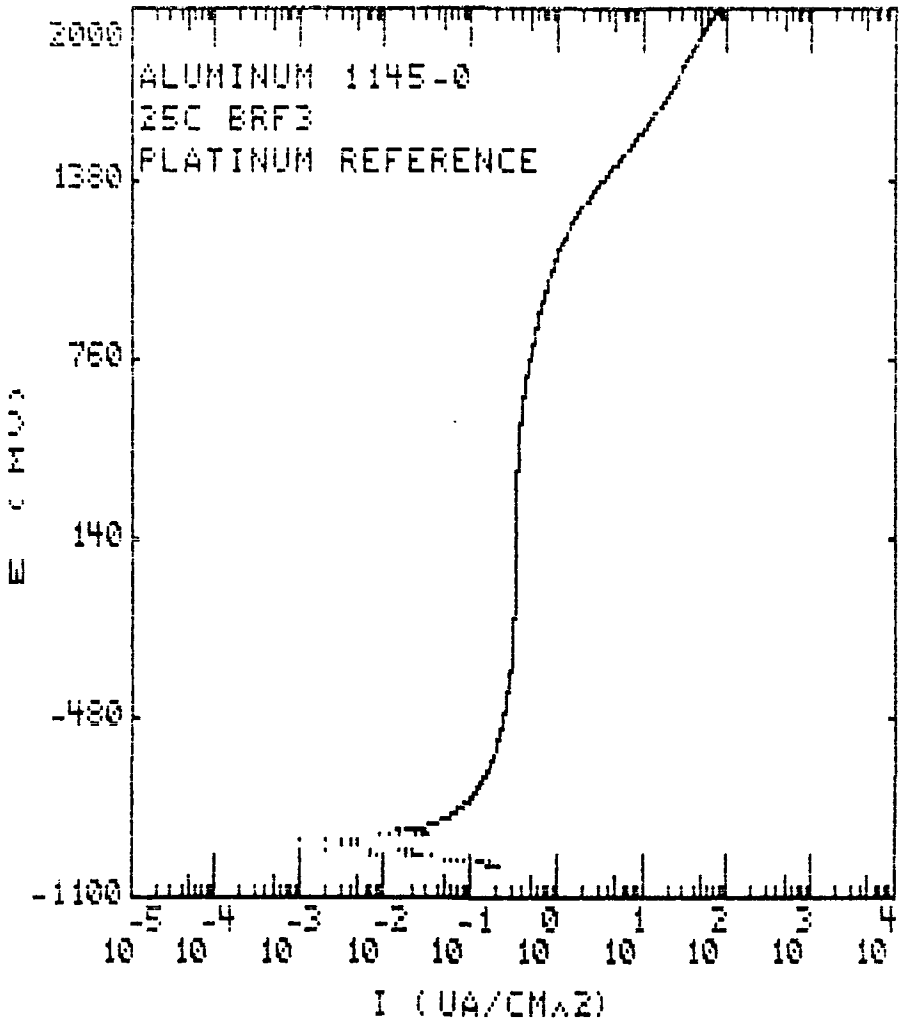

SUPERFERRIT
25C BRF3
PLATINUM REFERENCE
2000
1390
760
140
-480
-1100
E (MV)
I (UA/CM^2)

Figure 7



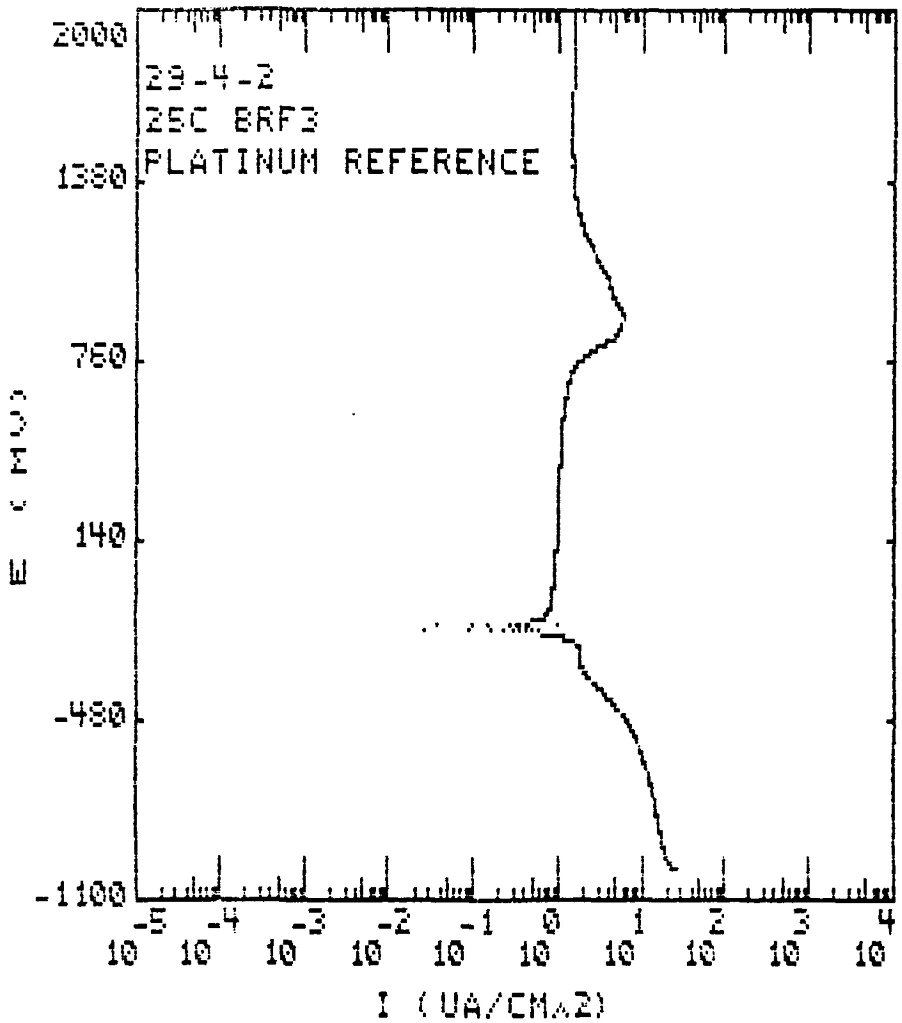
NICKEL 200
25C BRF3
PLATINUM REFERENCE
2000
1380
760
140
-480
-1100
E (MV)
-5 10
-4 10
-3 10
-2 10
-1 10
0 10
1 10
2 10
3 10
4 10
I (UA/CM^2)

Figure 8



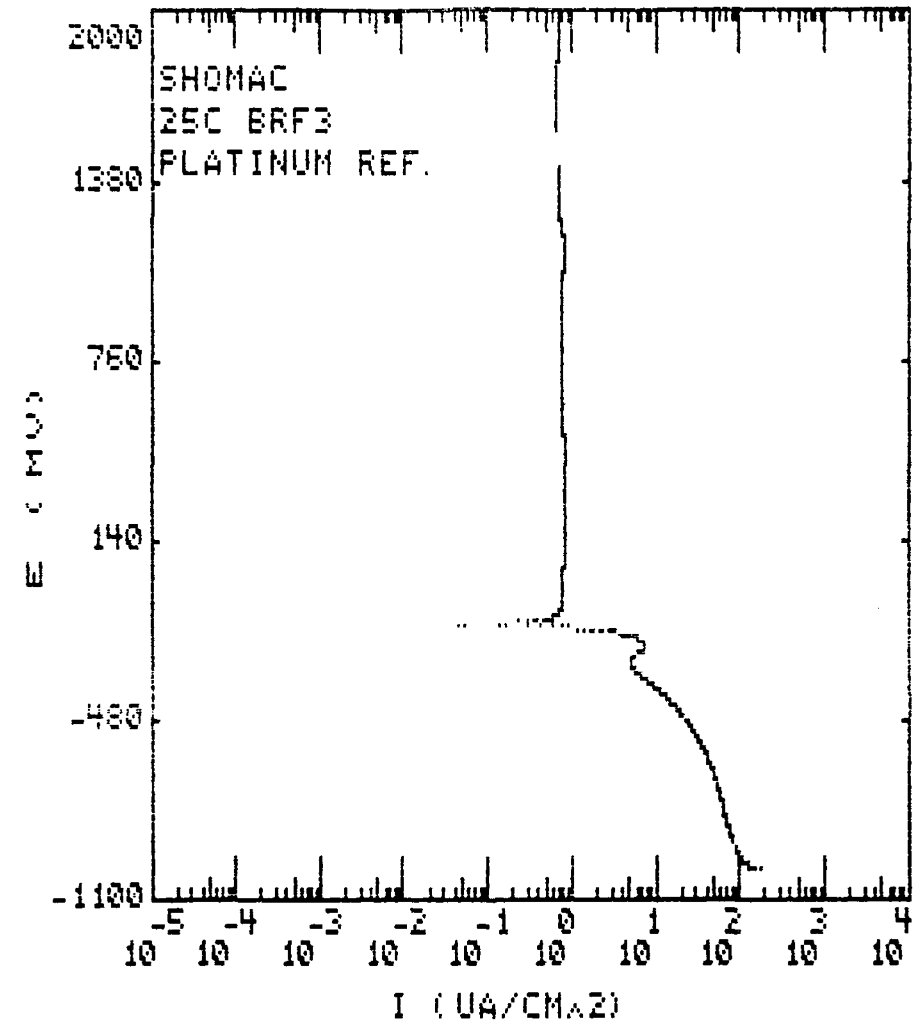
ALUMINUM 1145-0
25C BRF3
PLATINUM REFERENCE
2000
1380
760
140
-480
-1100
E (MV)
-5 10
-4 10
-3 10
-2 10
-1 10
0 10
1 10
2 10
3 10
4 10
I (UA/CM^2)

Figure 9



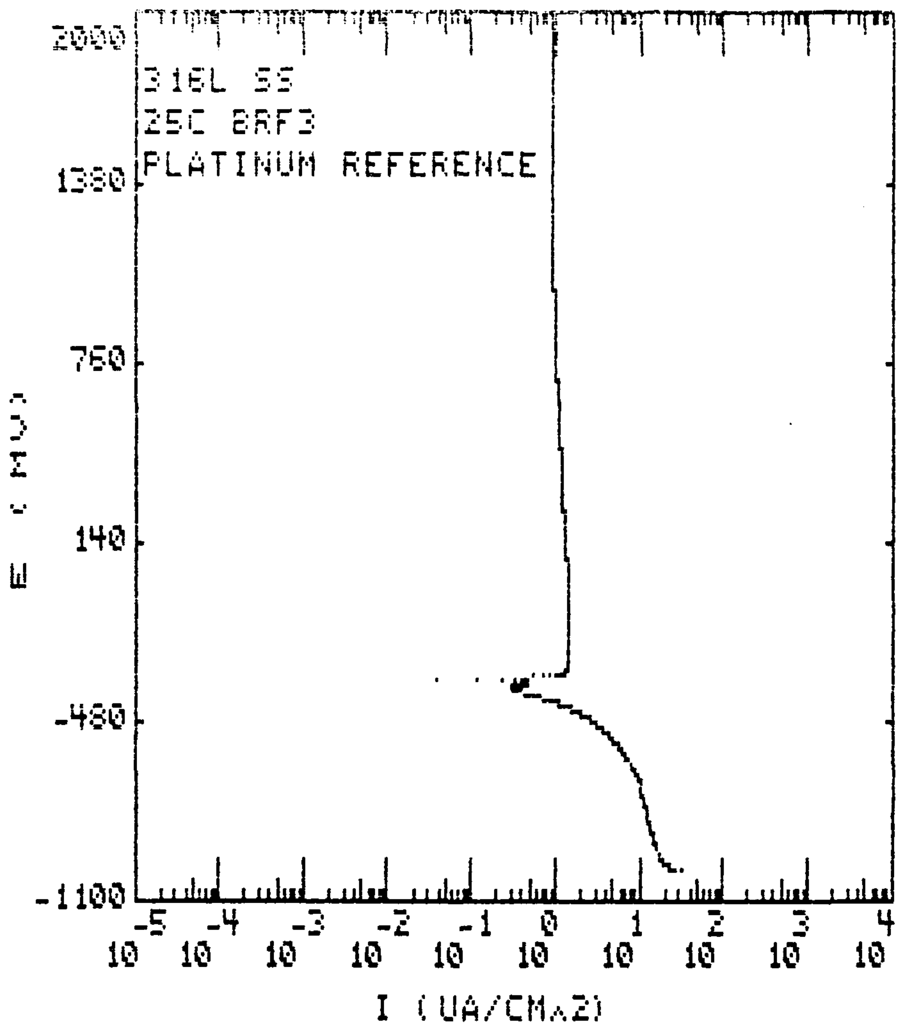
29-4-2
25C BRF3
PLATINUM REFERENCE
2000
1380
760
140
-480
-1100
E (MV)
I (UA/CM^2)

Figure 10



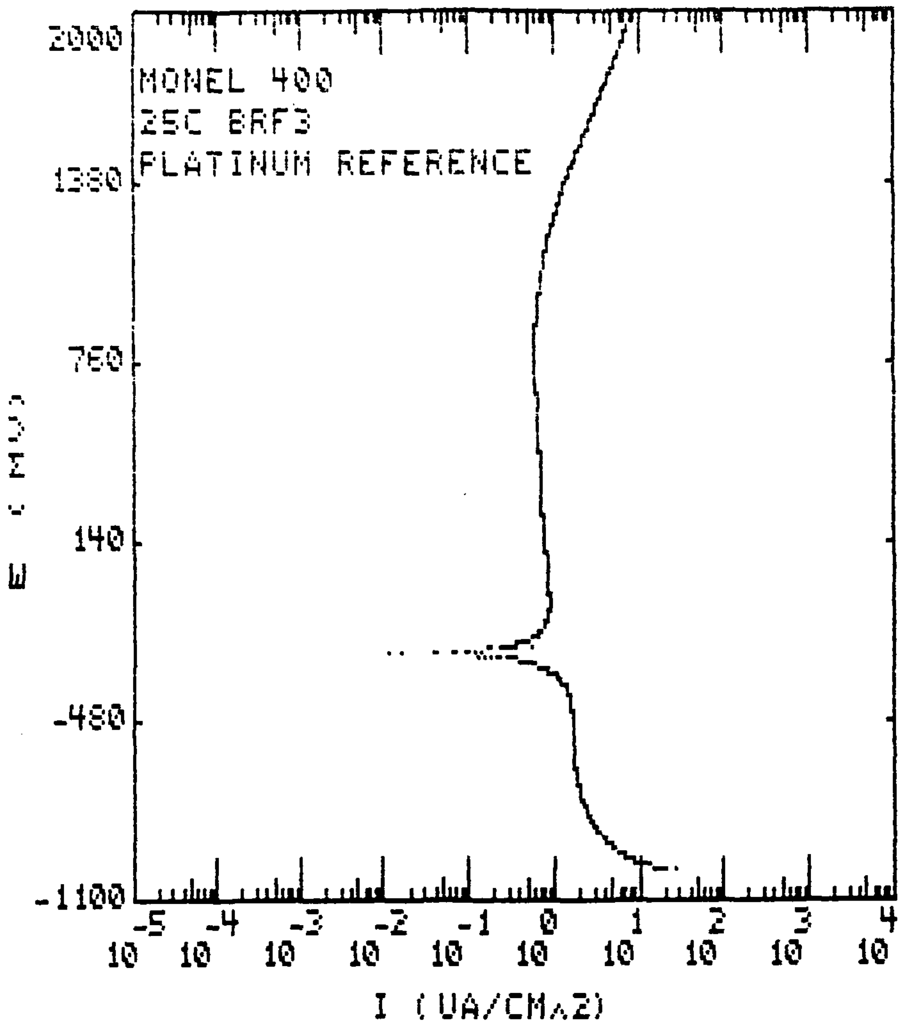
SHOMAC
25C BRF3
PLATINUM REF.
2000
1380
760
140
-480
-1100
E (MV)
-5 10
-4 10
-3 10
-2 10
-1 10
0 10
1 10
2 10
3 10
4 10
I (UA/CM^2)

Figure 11



316L SS
25C BRF3
PLATINUM REFERENCE
2000
1380
760
140
-480
-1100
E (MV)
-5 -4 -3 -2 -1 0 1 2 3 4
10 10 10 10 10 10 10 10 10 10
I (UA/CM^2)

Figure 12



MONEL 400
25C BRF3
PLATINUM REFERENCE
2000
1380
760
140
-480
-1100
E (MV)
-5 10
-4 10
-3 10
-2 10
-1 10
0 10
1 10
2 10
3 10
4 10
I (UA/CM^2)